LWA1 Technical Review

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LWA1 Users Meeting – Aug 29, 2013

~10-88 MHz usable, Galactic noise-dominated (>4:1) 24-87 MHz

4 independent beams x 2 pol. x 2 tunings, each up to ~17 MHz BW

Beam SEFD ~[6,30] kJy for Z=[0,65^o],

- **Also depends on sidereal time, (RA,Dec) of pointing, frequency**
- **~ 5 Jy (5σ) for 1 s, 16 MHz, Zenith**

Main lobe FWHM < (3.2^o)((74 MHz)/ν)$^{1.5}$ for Z<45^o

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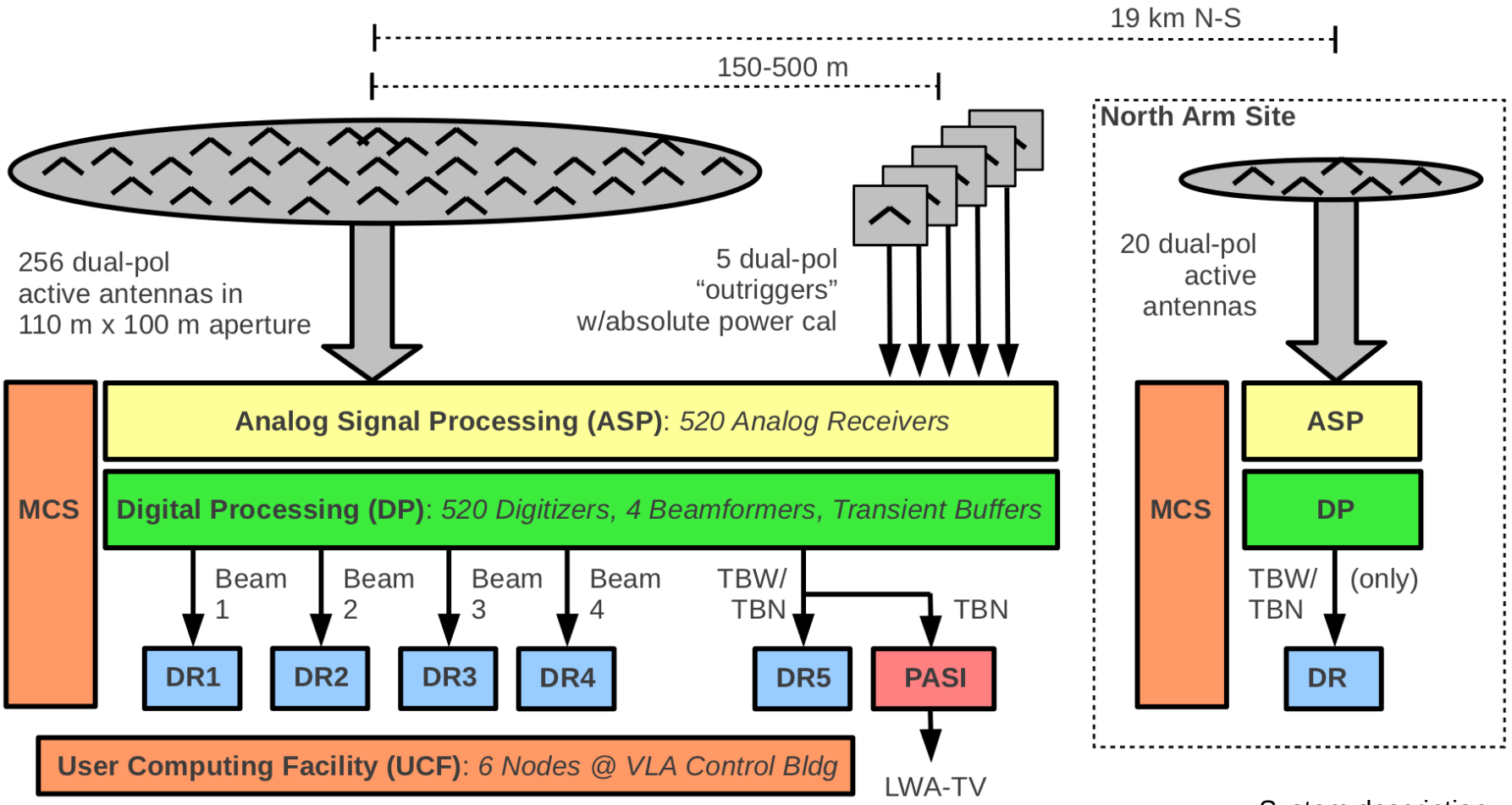
LW1 Observatory Architecture



"TBN" mode provides all dipoles, continuously (~70 kHz BW)
"TBW" mode provides all dipoles in 61 ms bursts (~70 MHz BW)

System description:
astro-ph/1307.0697
astro-ph/1204.4816

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LWA1 Outcomes

Published Science!

Ellingson *et al.* 2013, "Observations of Crab Giant Pulses in 20-84 MHz using LWA1", *ApJ*, 768, 136.

Helmboldt *et al.* 2013, "Passive over-the-horizon radar with WWV and the first station of the Long Wavelength Array", Radio Sci., *in press*.

Dowell *et al.* 2013, "Detection and Flux Density Measurements of the Millisecond Pulsar J2145−0750 below 100 MHz," *ApJL*, *in press*.

Most Recent Published Technical Description

Ellingson, Craig, Dowell, Taylor & Helmboldt 2013, "Design and Commissioning of the LWA1 Radio Telescope", *IEEE Int'l Symp. on Phased Array Sys. & Tech.*, astro-ph/1307.0697.

Ellingson *et al.*, "The LWA1 Radio Telescope", *IEEE Trans. Ant. & Prop.*, Vol. 61, No. 5, May 2013, pp. 2540-9. astro-ph/1204.4816.

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Beam Sensitivity

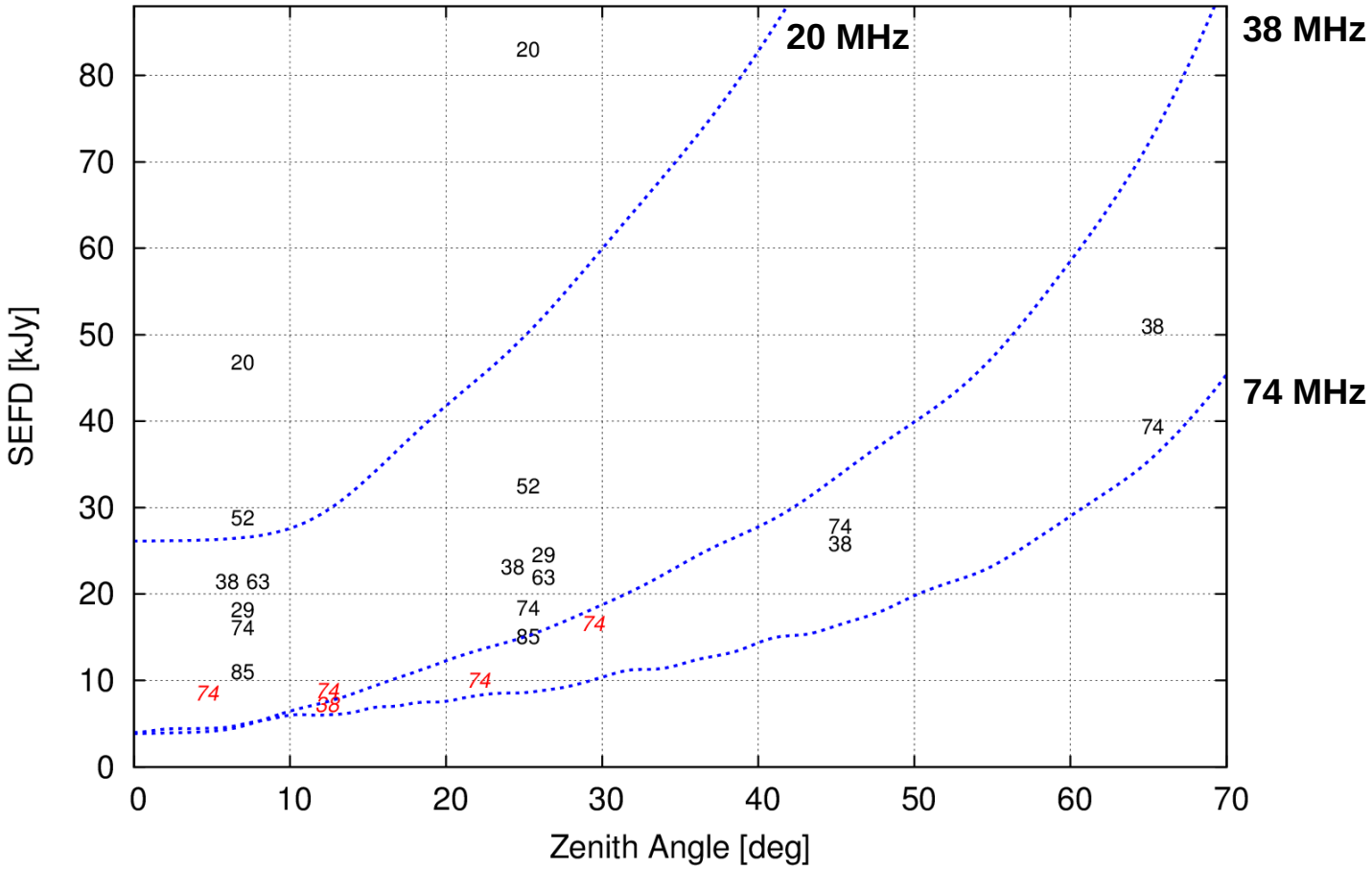
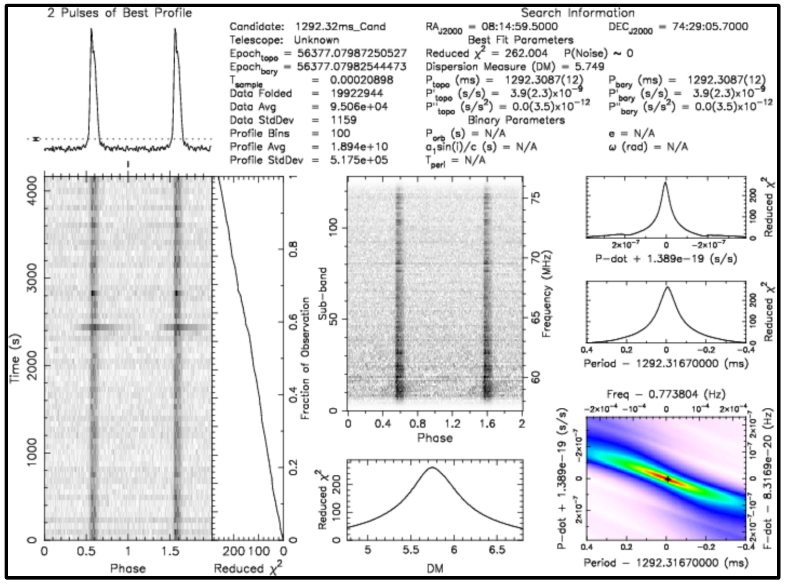


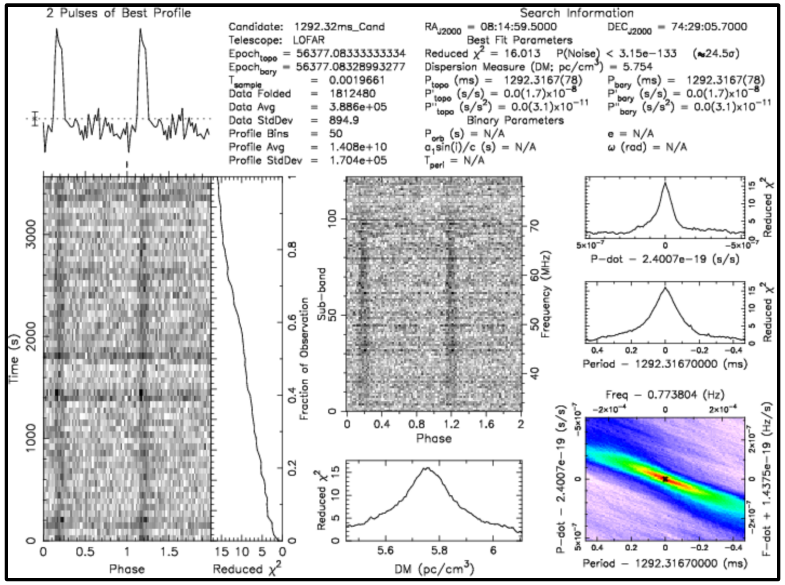
Fig. 11. Sensitivity (SEFD) vs. Z obtained from drift scans. The numbers used as data markers indicate the frequency rounded to the nearest MHz. Markers in red italic font represent transit drift scans of the sources 3C123 ($Z = 4.4°$), Tau A (12.1°), Vir A (21.8°), and 3C348 (29.1°); all others are Cyg A. The curves are predictions from Fig. 8 of [9] for (bottom to top) 74, 38, and 20 MHz. The use of both polarizations is assumed.

astro-ph/1204.4816 (*IEEE Trans. Ant. & Prop.*, *May 2013*)

LWA1 Compared to LOFAR Int'l Stations

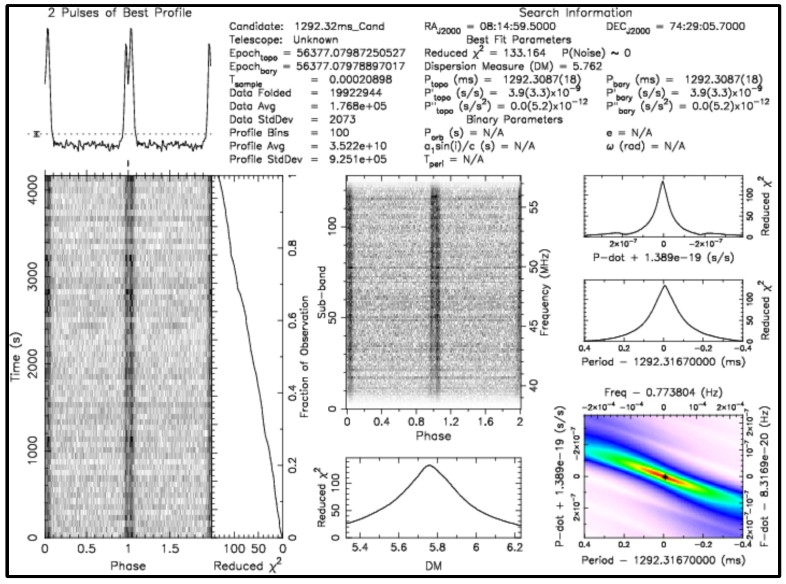
LWA1
59-75 MHz

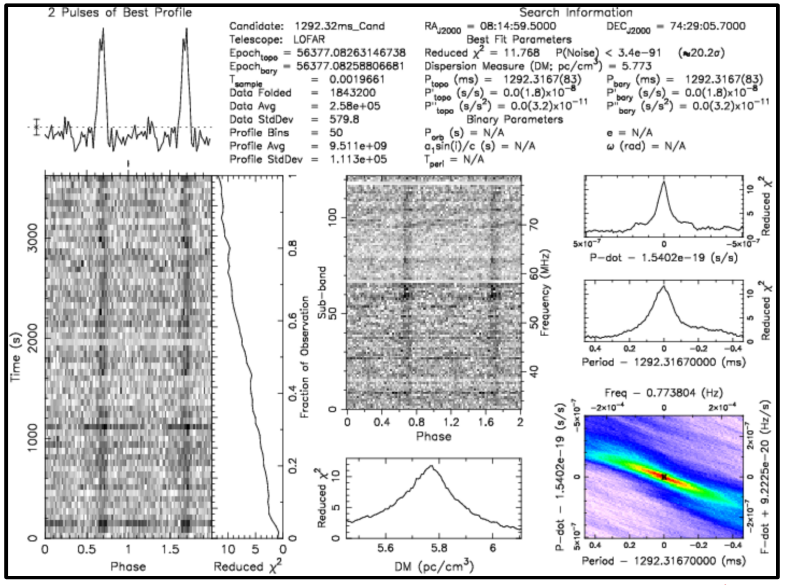




LOFAR
SE607
(Onsala)
36-75 MHz

LWA1
40-56 MHz





LOFAR
DE601
(Effelsburg)
36-75 MHz

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PSR B0809+74

O. Wucknitz (U. Bonn), F. Schinzel (UNM), D. McKay (KAIRA), T. Carozzi (Onsala)

LWA Long Wavelength Array

Since Last Year's Meeting...

Beam pointing error problem licked Sep 2012 (LWA Memo 194)

New observing modes:
– TRK_JOV (Jupiter tracking),
– TRK_SOL (Solar tracking),
– STEPPED (Fixed pointing, Alt/Az pointing, & Custom beams)

User Computing Facility (UCF) for on-site computing (LWA Memo 193)

DR Spectrometer #channels increased from 32 to 64-1024 (2048)
– At max BW, Δt between 3 ms – 160 ms (depends on #channels)
(Possible Δt's increase proportionally with decreasing sample rate)

 # Outriggers increased from 1 to 5
– Distances roughly 150 – 500 m from center of array
– Absolute power (Dicke switching) calibration (in progress)

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Array Calibration

LWA1 does “delay & sum” beamforming

“Array calibration” means figuring out instrumental delays so appropriate geometrical delays can be implemented

TBN procedure developed (see Memo 186 / astro-ph/1204.4816)

Initial application of TBN procedure worked well (Cyg A near zenith)

Second application of TBN procedure ~Summer 2012 yielded poor results, probably due to inappropriate source (Sun, low elevation)
– Sensitivity of DRX degraded ~50% during Fall 2012

Faster TBW-based procedure developed (see Memo 197 / astro-ph/1307.0697); applied; array appears to be properly recalibrated

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Other Warts

RFI (#1 problem: power lines, #2 problem: VLA site activity)

Beam tracking still degrades TBN

DP: Timetag offsets and glitching
– Usually associated with center frequency changes
– Does not affect data, but makes checking data integrity difficult

(Packets out of order "problem"? – NOT!)

DR: Gaps in a small % of files (detectable as timetag jump)

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Technical Development Priorities

Flux density calibration

External Triggers
- **External – GCN**
- **Internal – PASI**

RFI Mitigation
- **Auto-baselining / flagging**

Beam sensitivity improvements
– Gain equalization (~10% SEFD improvement)
– Max SNR (~50% SEFD improvement)

Polarization

Sidelobe characterization

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VT ASCED+Loa Project

ASCED = "Advanced Science Collaboration Environment & DMZ"
– NSF project @ VT (Gardner (PI), Wolfe, Ellingson + collaborators)
– Sustained 900 Mb/s data transfer UNM – VT, demonstrated
– Feed data into pipeline on VT supercomputing, in development

Loa: Lightweight DRX spectroscopy & pulsar dedispersion code
– Used in LWA1's first published astronomy paper
– Currently being extended to do fast automated Crab GP & dispersed transient search (baselining, RFI mitigation, DM sweep)

ASCED+Loa:
– Pipe data from UNM to VT supercomputing resources
– Run Loa-based parallel processing to search for Crab GPs & dispersed transients
– Support concurrent access to this data flow by other parties (not just VT) for other science – *Let us know if you are interested...*

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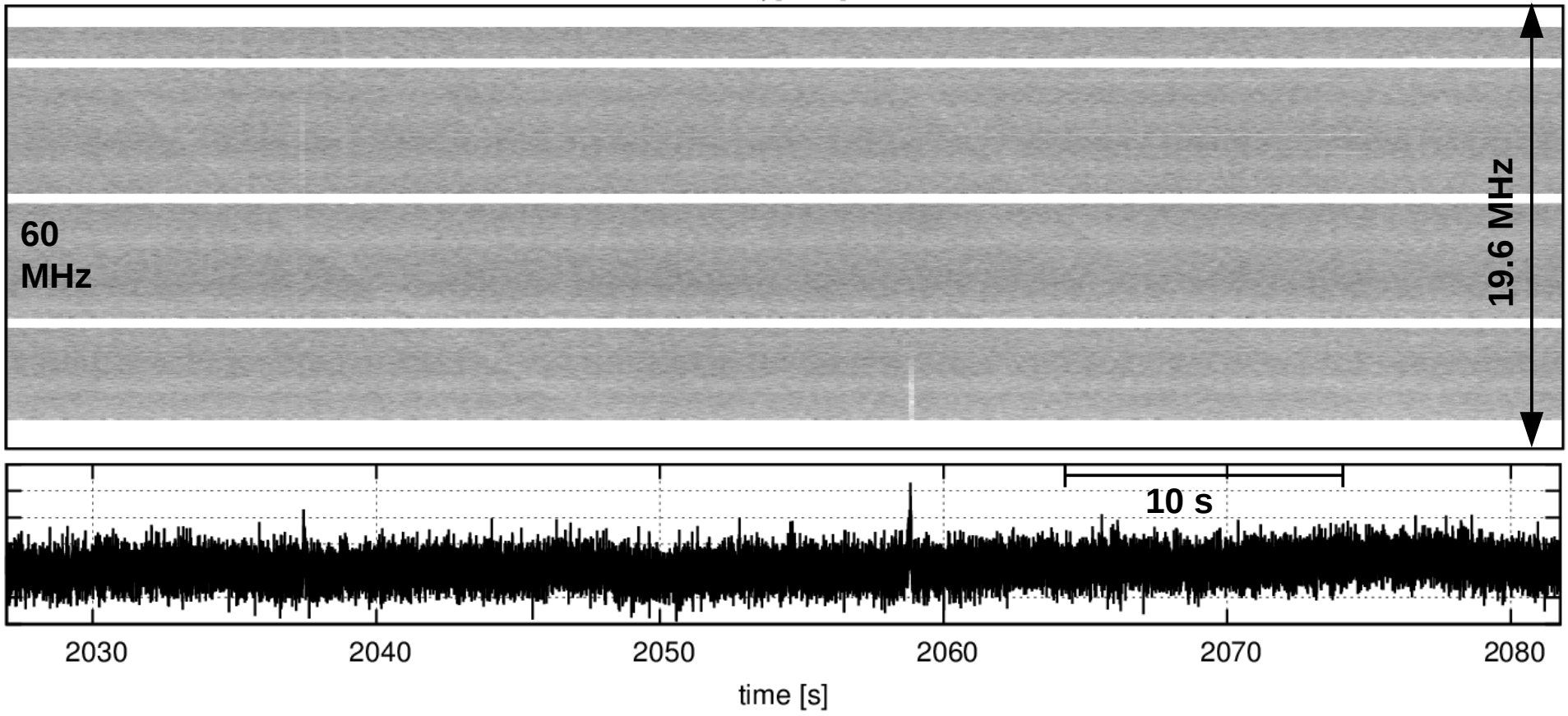
Questions?



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